JPL Robotics Technology Applicable to Agriculture

From

Mobility and Robotics Systems Section

NASA - Jet Propulsion Laboratory,

California Institute of Technology

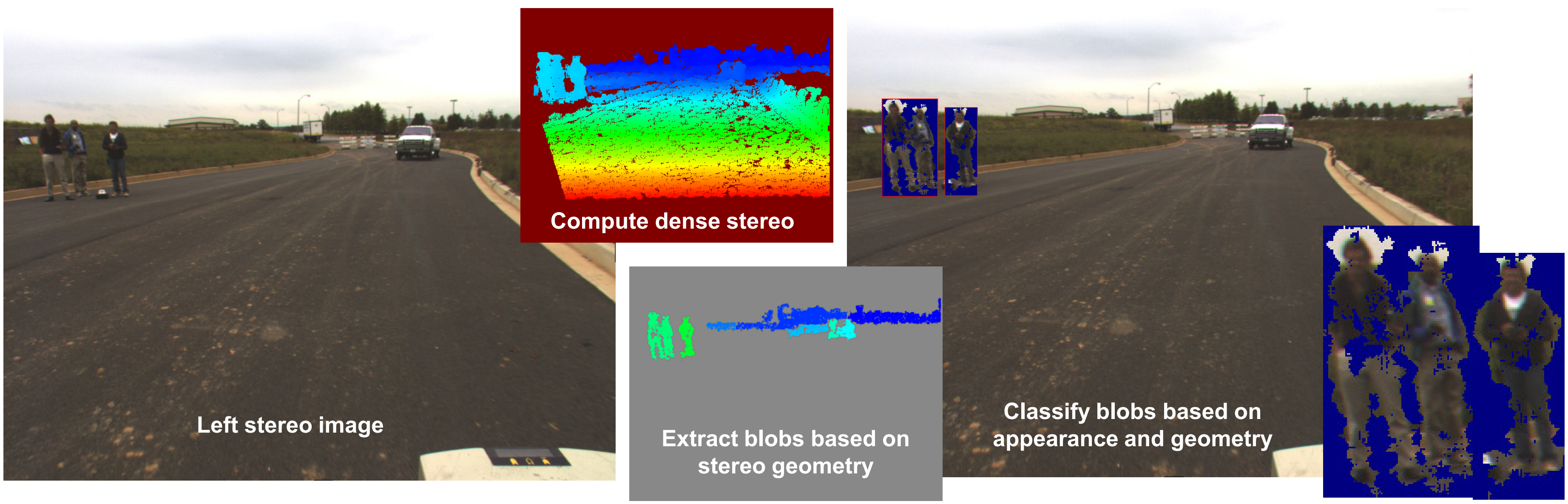
To

Jeff Steiner

USDA Agricultural Research Service

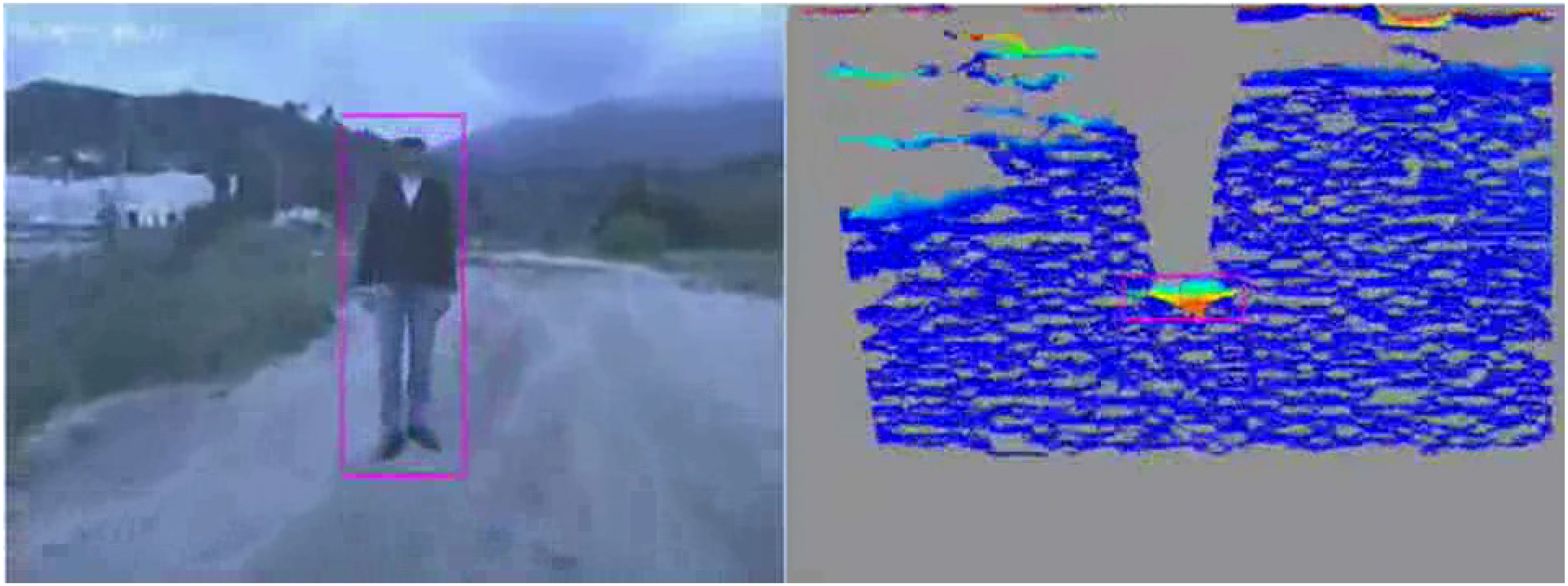
Human Detection for Safe Operation of Autonomous Vehicles

- **The ability to detect humans is the most important capability for safe operation of autonomous vehicles.**
- **Stereo vision-based detection combines geometry and appearance methods for improved detection rates and range.**
- **Algorithms run in real-time onboard vehicles navigating outdoor, unstructured environments.**
- *POC: Andrew.Howard@jpl.nasa.gov*



Real-time Human Detection Movie Screenshot

(see http://www-robotics.jpl.nasa.gov for full movie)



Automated Plant Micro-Propagation

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Participating Org.:
NASA/JPL
Industry partners

Objectives:

- Develop vision-guided robotic techniques for shoot selection, separation and transfer to growth media
- Reduce cost and improve efficiency over manual micro-propagation procedures

Next Steps:

- Integrate machine vision to select, separate, and transfer shoots in the multiplication phase of plant-micro-propagation
- Demonstrate economical feasibility of an automated system

Product:

- Robotic work cell utilizing commercial off-the-shelf (COTS) hardware
- Custom software using JPL's robotic vision and manipulation algorithms
- Turn key operation with simple operator interface
- Achieve faster operation than current manual techniques
- Demonstration in a commercial setting

Accomplishments to date:

- Developed a novel robotic prototype work cell for automated plant shoot preparation
- Established cost baseline for single work cell fabrication with COTS parts
- Demonstrated potential of use of robotics to increase efficiency over manual technique
- Set-up micro-propagation work cell and demonstrated two robotic manipulation techniques
- Evaluated multiple plant preparation techniques and experimentally evaluated their performance

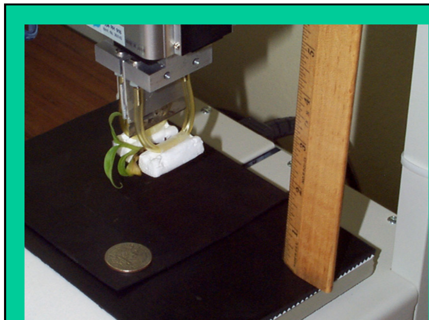
Justification

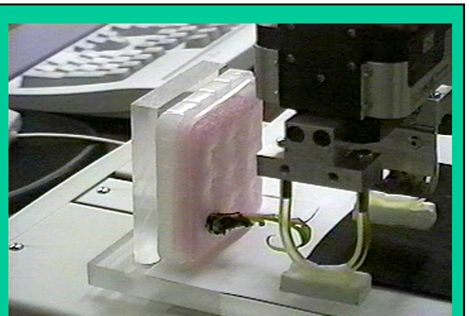
- Current labor intensive techniques are economically viable primarily for high-value ornamental plants
- Economics of current techniques is driving this industry to other countries where labor is cheaper
- Automation would make micro-propagation more economically viable and widely used
- Maintaining sterile laboratory and clean-room conditions is easier with robotic systems
- Robotics systems can reduce repetitive motion injuries among technicians performing shoot selection, separation and transfer operations
- JPL is a world leader in research and development of robotic vision and manipulation technology
- JPL has prior experience and demonstrated success in addressing this technology area

Approach

- Collaborate with the industry and federal organizations to identify participants and target applications
- Design a robotic work-cell for automated micro-propagation using commercially available hardware
- Develop autonomous vision-guided manipulation techniques to selectively perform plant shoot separation and transfer to growth media
- Work with collaborators to demonstrate in an industrial setting

Accomplishments to date


Pick-up and cut


Shoot insertion

Cut-and-insert technique


Input & output trays in robot work cell


Cut & puff out tray at completion

Cut-and-puff technique

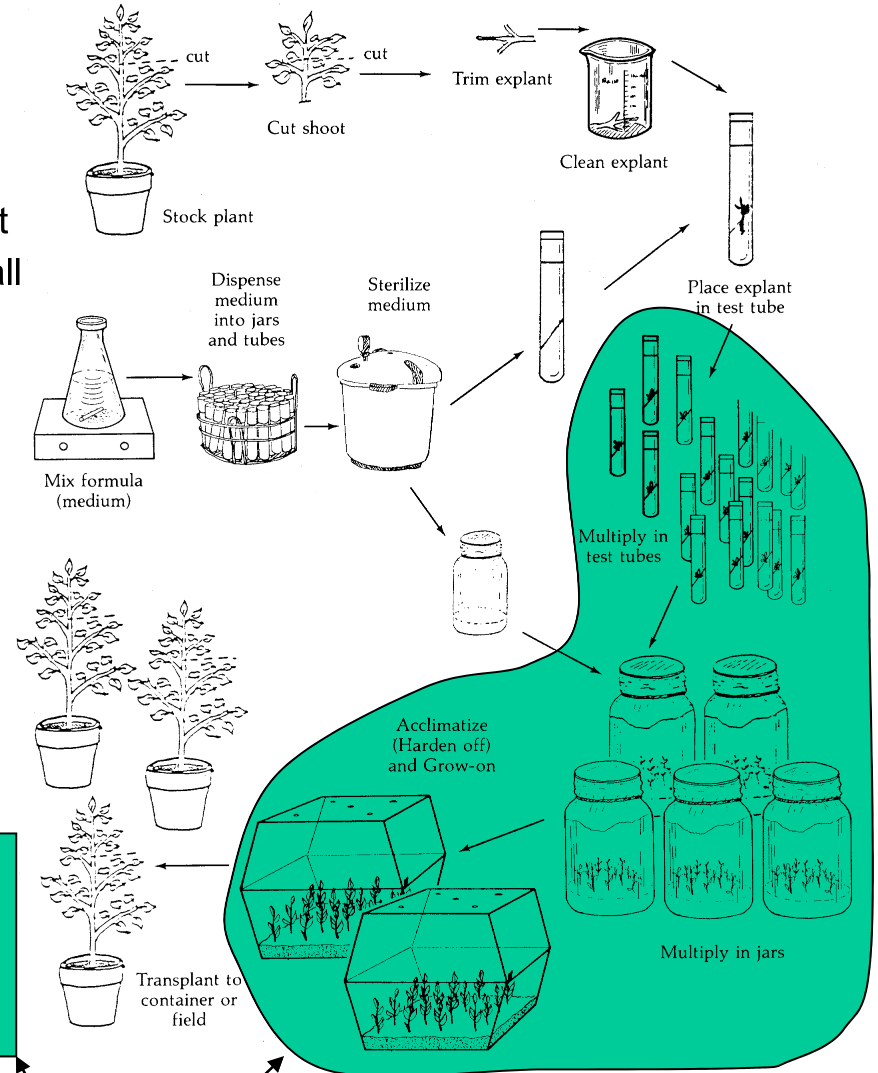
Background

Micropropagation in commercial use for 30+ years

- Propagate plants from shoot tips (meristemic tissue)
- Use culture media and plant hormones to control growth (branching, rooting)
- Facilitates quick introduction of a plant into the market
- Rapid production of a large number of plants in a small amount of space
- Production in a laboratory is not limited by seasons
- For some plants it is the only method available for propagation
- Facilitates production of disease-free plants
- Very labor intensive, requires skilled technicians
- Currently commercially viable for high-value (ornamental foliage) plants

<u>Micro-propagation Steps:</u>

1. Cut shoot from stock plant and sterilize it
2. Place in growth jars with growth media; leads to multiplication of shoots
3. Separate shoots from each other
4. Repeat steps 2, and 3 for as many shoots as needed
5. Transfer shoots to rooting media to grow roots
6. Transfer rooted plants into liners and grow plants
7. Deliver to customers



From: L. Kyte, “Plants from Test Tubes,” Timber Press, 1987.

Automate